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Agricultural Experiment Station

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Department of Chemistry

Soils of the Cut-and Burned-Over Areas of North Idaho

A BONNER COUNTY STOCK FARM

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SOILS OF THE CUT-AND BURNED-OVER AREAS OF NORTH IDAHO

In the panhandle of Idaho, particularly in the counties of Bonner, Kootenai and Latah, are extensive areas of raw lands awaiting the coming of farmers and stockmen. The early settlement of these lands is of course a consideration of vast importance to the state as a whole but of equal importance is their settlement by men and women possessed of some information regarding the nature of the problems they are to encounter in the building here of comfortable and attractive farm homes. To secure the information necessary for answering specific questions relative to these lands, a survey was undertaken some two years ago. Our purpose now is to present as concisely as possible such general and specific information concerning them as field observations and laboratory data seem to justify.

AREAS SURVEYED

A detailed survey such as would be necessary for the accurate location of the boundaries of soil types was not feasible, but predominating types were recognized and their physical and chemical characteristics determined. A general description of the lands in question can best be given by counties.

BONNER COUNTY

By far the larger part of Bonner county capable of being put under cultivation is referred to locally as bench land. By that term is meant land which is reached by one or more fairly well defined ascents from stream or lake. Between streams or lakes and foothills of mountains too precipitous to be considered for agricultural purposes, there may be several well defined benches each higher than the one immediately below it by 50, 75 or even 100 feet. Any one bench is usually very nearly level or if rolling only slightly so. This condition makes possible on them a large number of very desirable farm sites, although the section as a whole may very properly be referred to as mountainous. Because of their low content of organic matter, their color and the prominence of sands and silt in their mechanical make-up, these bench lands may be described as heavy, red sandy or silt loams. Certain extensive areas to a depth of several feet consist of fine soil only. Throughout other extensive areas the fine soil is highly charged with gravel, small rocks and even boulders. The terms gravelly and stony should, therefore, frequently precede the general terms used above as descriptive of type. The percentage admixture of gravel and coarser rocks should of course be taken into consideration in determining the kind of agriculture best suited to any particular locality. It is question-

able if any encouragement should be given the breaking up of the coarse gravel and stony loams. They afford in their natural state splendid pasturage and with such improvement as could be made readily should become highly prized for grazing purposes.

These benches have produced magnificent growths of yellow and white pine, fir, tamarack and cedar. They are the typical cut or to-be-cut-over lands of Bonner county. We have repeatedly traveled over and examined them in the field and in the vicinity of Bonners Ferry, Careywood, Clagstone, Coleman, LaClede, Naples, Newport, Pack River and Sandpoint have secured samples for laboratory examination.

Two large rivers, the Kootenai and the Pend d 'Oreille, flow across the county, the first mentioned in a northwesterly and the second in a westerly course.

The valley of the Kootenai from a point several miles above Bonners Ferry to the Canadian boundary is broad, low and flat. Because of natural obstructions in the mouth of the river, the lowest of the low lands are annually flooded in May or June to a depth of several feet. The soils of the valley are, therefore, alluvial and of great depth. They are dark gray sandy or silt loams highly charged with limestone leached from the subsoils of the bench lands to the north and east or carried as alluvial material from limestone beds farther up the river and deposited annually by the flood waters. Samples for laboratory examination were taken up and down the river from Bonners Ferry.

The valley of the Pend d'Oreille is likewise broad, but the low-lying benches come so close to the river's edge as to enable one to describe the valley as rolling. A noteworthy exception to this description exists at Clark's Fork; there the valley resembles that of the Kootenai in topography. The soils of the Pend d'Oreille valley are essentially low-lying bench soils, with occasional restricted areas of an alluvial nature.

Besides the low lands of these two river valleys, there are those of old lake bottoms. Some, like those at Clagstone, are very rich in organic matter and of uniform composition to a great depth. They are typical mucks. Others, notably those in the vicinity of Careywood, are light gray silts of great depth overlaid with four to five inches of alluvium highly charged with organic matter.

KOOTENAI COUNTY

The red colored bench lands which predominate in Bonner are characteristic also of Kootenai county. In the extreme north end of the county they contain a high percentage of gravel or small stones and are thickly studded with granite and other boulders of substantial proportions. These, like those they join in Bonner county, are best adapted to grazing purposes. Elsewhere in the

county, as on those benches which border Coeur d'Alene lake, St. Joe and St. Maries rivers and on the higher but still rolling sections in the south end of the county, the characterization used in describing the predominating bench type in Bonner, viz., fine sandy or silt loams, still holds. As representative of these lands, laboratory samples were secured in the vicinity of Athol, Coeur d'Alene, Chilco, Fernan Lake, Garwood, Harrison, Hayden Lake, Plummer, Rathdrum, Spirit Lake, St. Maries and Twin Lakes.

Extending north for a distance of twenty or twenty-five miles from the Spokane river as it flows from Coeur d'Alene lake almost due west to the Idaho-Washington line, and almost completely surrounded by the red timber lands, is an open prairie section with surface soils of decidedly different character from those previously noted. The northernmost section is called Eight-mile Prairie, the middle section Rathdrum Prairie and that immediately adjacent to the river the Spokane valley. Glacial erosion and recession are believed to have given this entire area its present configuration and topography. Its soils, intensely black or brown gravelly silt loams, are believed to be the drift of alluvial material carried from a distance by turbulent streams into the shallow post-glacial lake and deposited on its gravel bottom by sedimentation and the slow filtering away of the lake waters. Rathdrum and Eight-mile prairies have been for many years under cultivation. The lower end, or Spokane valley, for many years was passed by as worthless for farming purposes. Within the last few years much of it has been put under irrigation and settled by orchardists and small fruit growers. Splendid orchards are now growing where formerly existed a granite boulder-strewn expanse of inferior grazing land. The remaining portions doubtless will sooner or later be put under irrigation for orchard or trucking purposes. Laboratory samples were secured in the vicinity of Coeur d'Alene, Corbin Junction, East Greenacres and McGuire Junction.

The river valleys of Kootenai like those of Bonner county have extensive areas subject to annual over-flow. They are deep black alluvial sandy or silt loams, highly prized even in their native condition as meadow land. When dyked and drained they will prove to be exceedingly productive and adapted to a wide range of farm and truck crops. Here and there throughout the county are also old lake bottoms whose soils do not differ materially from those of Bonner county. Samples of river bottom soils were taken from the valley of the Coeur d'Alene above Harrison, and from the valleys of the St. Joe and St. Maries above St. Maries.

LATAH COUNTY

Approximately two-thirds of Latah county lies within the timber belt. The same fine red sandy and silt loams which characterize

the benches and high lands of Bonner and Kootenai counties are to be found in the north and east parts of Latah. The southwest part of the county belongs to the open Palouse prairies whose soils are of aeolian or wind formation. Prevailing southwest winds prevent a sharp line of separation between the red timber and the black open prairie soils; there is a belt of varying width at the margin of the timber which partakes somewhat of the nature of both. In the valley of the Palouse river which flows across the north half of the county from east to west there is some low meadow land. No extensive area, however, is subject to annual overflow. In this county samples for laboratory examination were secured in the vicinity of Avon, Bovill, Deary, Havard, Moscow, Potlatch, Princeton and Troy.

SELECTION OF FARM LANDS

These three counties do not include all of the tillable raw lands of north Idaho. Less extensive areas very similar in character to those already described lie in Clearwater and Shoshone counties adjoining Latah and Kootenai on the east. Just here we wish to emphasize this fact: In addition to a diversity of climatic and other conditions which make for or against success in farming operations, the prospective settler has before him in the panhandle counties of Idaho a wide range of soils to choose from—river and

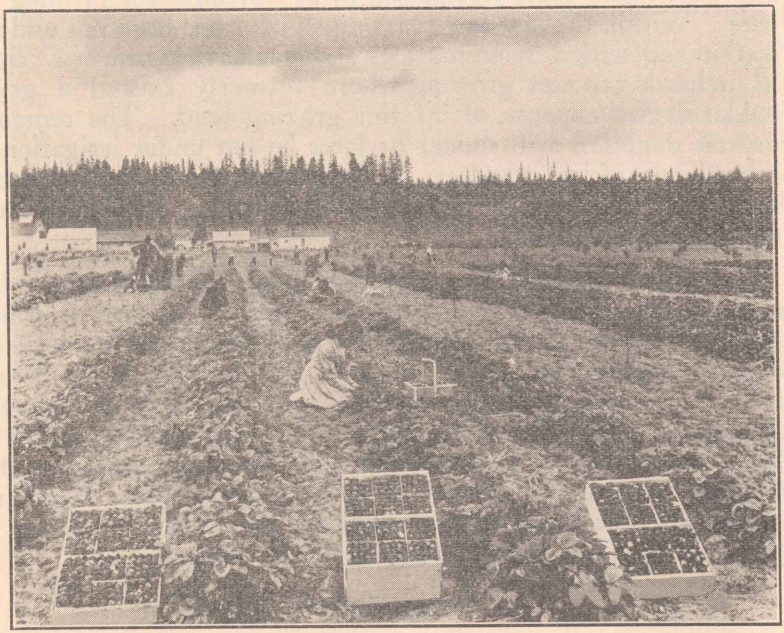

Fig. 1.—One stage in the development of an orchard on bench land in the valley of the Pend d'Oreille (Silver Birch Farm).

lake bottoms, bench lands and level open prairies. There are immense latent possibilities in each but some locations of course are far more desirable than others. In the development of paying farms on any of these raw lands peculiar problems must be solved, and of those who undertake their solution an unusual amount of energy, patience and thrift is demanded. Careful consideration of the following paragraphs we believe will aid materially, first in making satisfactory selections and, second, in getting started right when once the selections have been made.

ADAPTATION OF SOIL TO CROPS

There are at least two generally recognized requirements for good farm land, viz., depth—sufficient to permit the most complete development and widest range of plant roots, and richness—liberal supplies of the several essential elements of plant food. In application both terms of course are relative.

Generally speaking, western soils are remarkable for depth. Within the area whose general description has been given all types are possessed of reasonable depth and many should be classed with the most remarkable in this characteristic. The deepest perhaps are the alluvial ones of the river bottoms—of the Kootenai, St. Joe and St. Maries in particular. Many of the bench lands are scarcely less noteworthy in this respect. There are extensive areas of bench lands whose surface loams shade very gradually into soils differing in composition only by reason of a lower content of organic matter. Into these one might bore for several feet without encountering a distinct subsoil. In the soils of the river bottoms and in those of this type of bench land crop roots will find unrestricted range. There are on the benches and other uplands, however, here and there areas of less extent where tight silt clays beneath surface loams of four or five inches offer less favorable conditions for the free range of plant roots. The growth of strong deep rooted crops like alfalfa and red clover will eventually loosen this under soil and give it adaptability to a wider range of crops. Again there are other bench lands, not restricted to any one locality but easily recognized by even the inexperienced, whose soils are no less deep than those first mentioned but so highly charged with gravel, stones and boulders of varying size as to render them far less desirable for general farming purposes. They are the grazing lands of which it has already been said no particular encouragement should be given to their breaking up.

In the light of all that is now known in soil biology, soil analysis as that term is generally understood must be undertaken to satisfy less ambitious aims than those taken by chemists in times past. However, since all crops are harvested at the expense of fairly definite amounts of certain elements which the soil alone can supply,

this fact is firmly established: Data secured by systematic surveys and carefully executed analyses provide the only sound foundation upon which to base right procedure in farm practice. One may not question for a moment the powerful influences exerted by bacteria and other biological factors upon fertility, but he must not forget that the possibility of soils measured in terms of crop production over a term of years rests primarily upon their chemical composition. It will be well then to note carefully the significance of analytical data presented in Tables 1 and 2.

At least three million pounds of fine soil per acre, representing approximately nine surface inches of the uplands, where they are not too highly charged with gravel, and twelve surface inches of the low lands, are within feeding range of the roots of ordinary crops. Of these three million pounds growing crops make heavy demands for nitrogen, calcium, magnesium, phosphorus, potassium and sulphur. In Table 1 are recorded absolute amounts of these elements found in the various fine soils by chemical analysis; in Table 2 the yearly demand by various crops for the same elements. From the proper use of these two tables, it is possible to arrive at definite conclusions regarding the native richness of the soils in question.

The most commonly accepted method of treating data of this kind is to divide the number which represents the content of any one element in the surface fine soil by the number which represents the amount of that element required in the making of an average crop; assuming the possibility of complete exhaustion, the result is set down as the number of years required to exhaust completely the fine soil of that particular element. From Table 2 it is evident that of the several mineral elements, calcium and potassium are used by growing crops in greatest amounts. If now the calculations just indicated be made, it is evident that each of the fine soils has a supply of these elements sufficient to meet the demands of growing crops for several hundred years. So also for magnesium. If the suggestions on farm practice offered later on be adopted, neither calcium, potassium or magnesium need ever for these soils become limiting factors in crop production.

In all agricultural countries, the relative demand of farm crops for phosphorus to their soils' native supply of that element is a consideration of such vast economic importance that the so-called phosphorus carriers are among the most highly prized of commercial fertilizers. In eastern, southern and middle-western states the necessity for phosphorus fertilization invariably appears after a few years of cropping. That necessity will eventually manifest itself on these lands. Since, however, in their native supply they stand among the highest of all soils in phosphorus content, for them the necessity of phosphorus fertilization is as far distant as it is for the richest of farm lands. Three million pounds of surface fine soil

contain the equivalent of phosphorus necessary for fifty or more four-year rotations.

The statement that sulphur rarely, if ever, becomes a limiting factor in crop production was generally accepted until recently produced evidence was brought forward to prove that the sulphur requirements of farm crops have been considerably under-rated. In absolute amounts this element must be considered low in most of these fine soils; fifteen to twenty four-year rotations require practically as much sulphur as they contain. On the other hand the annual precipitation materially supplements the native supply. Experimentation with sulphur-carrying fertilizers can be made to settle questions relative to the necessity or advisability of sulphur fertilization. Such experimentation for the bench lands is now being conducted on the Sandpoint sub-station farm.

Nitrogen is a constituent of the soil's organic matter. Only in the final products of decomposition does it become available as plant food. In organic matter many of the low lands—river and lake bottoms—are extremely rich; all should be considered more than ordinary well supplied. Because of their great depth and the uniformity in distribution of organic matter, nitrogen fertilization for them will never become a necessity. On the benches and uplands, conditions are different. Organic matter is low in amount and concentrated in the surface four or five inches. Four four-year rotations, sixteen years' cropping with potatoes, oats and clover, or two six-year rotations, twelve years' cropping with wheat, alfalfa,

Fig. 2—Product of dyked land in the St. Joe valley.
Photo by Trueman.

mangels, barley and peas call for as many pounds of nitrogen as are contained in the average surface three million pounds of Bonner county bench land. Although Kootenai and Latah county bench lands are somewhat richer in organic matter and nitrogen, this element for them also must be considered the limiting factor in crop production; for one characteristic property of the organic matter of these soils is its slow rate of decomposition. For success in cropping the bench lands it is absolutely essential that steps be taken at the outset to increase the native supply of organic matter and nitrogen. The open prairies in Kootenai county are the richest of all the uplands in these essential constituents. Here the pressing necessity is not so much an increase of organic matter as it is of effecting the liberation of nitrogen already contained in the native supply. A practical method of accomplishing this result will be suggested in a succeeding paragraph.

The practical application of the preceding paragraphs for the man who has decided to build for himself and family a farm home in this section of the state is this: The low lands require only protection against flood waters and draining to insure high productivity from the start. When properly dyked and drained they can be put under cultivation just as easily as open prairie lands. They are natural meadow lands rich in all the essential elements of plant food and will prove to be adapted to a wide range of truck and general farm crops. The bench and other high lands are rich in the mineral elements necessary for plant growth but the highest possible success in crop production on them will not follow as a matter of course the removal of stumps and brush. Steps must be taken immediately following their breaking up to correct their deficiency in nitrogen and active organic matter. For the gravelly open prairies, an increase of nitrogen and organic matter is perhaps not an immediate necessity but steps may well be taken at once to render more readily available the native supply. Unquestionably in the management of the cut and burned-over lands the key to immediate and permanent success is a thorough understanding of practicable means of getting the element nitrogen into them and of making it available as plant food.

IN CROP ROTATION LEGUMES MUST BE PROMINENT

There are on the market various nitrogen-carrying fertilizers—sodium nitrate, ammonium sulphate, calcium cyanamid, calcium nitrate, dried blood and other manufactured products. The application of any of these substances following the breaking of the raw land and its thorough preparation for cropping purposes would immensely stimulate plant growth of all kinds. Nitrogen in this form, however, will cost the man who needs it a price which he cannot for the growth of ordinary farm crops afford to pay. For

these lands it must and may be secured for a much smaller outlay of cash. Growth of leguminous crops, clovers, peas and vetches, under conditions which stimulate to activity the associated nitrogen-gathering bacteria and close adherence to that system of farming which this kind of cropping necessitates is the only practical solution of the nitrogen problem.

Since clovers start readily on burnings and make splendid growths on raw lands among the stumps, it would seem that little or no difficulty need be expected in the growing of any legume for soil improvement purposes when later stumps have been removed and fields reduced to a cultivated condition. On certain types of bench land—those of open texture—this is true. Peas, clover and alfalfa rival in production the same crops grown in such open prairie sections of the state as the Palouse and the Nezperce. In the closer-textured types an acid condition manifests itself in cultivated fields which must be corrected before the primary purpose for which legumes are grown can be fully realized. In acid soils the nitrogen-gathering bacteria which usually associate themselves with the legumes will not work to full capacity. If nitrogen is to be taken from the inexhaustible store of that element in the atmosphere and made a part of plant life through the agency of these minute bodies, conditions which stimulate them to their peculiar activity must be provided. The soil acids must be neutralized. Limestone is the corrective agent for soil acidity. Its application at the be-

Fig.3—Peas on a gravelly silt loam. The soil was limed and the seed inoculated with nitrogen-gathering bacteria. Clagstone demonstration farm. Photo by Heideman.

ginning of the rotation in amounts of two to three thousand pounds per acre and the inoculation of legume seed with nitrogen-gathering bacteria previous to sowing will insure not only the success of legume crops in these soils but the gradual storage of nitrogen in them for the benefit of the non-legumes of the rotation.

There is already for the bench lands sufficient practical farm experience to warrant the statement that with rigid adherence to plans of crop rotation which give decided prominence to the legumes, the feeding on the farm of everything produced and the prompt return to the soil of all manure and composted litter the one deficiency of these lands will be readily taken care of and high productivity made possible.

The gravelly open prairie soils also have developed an acid reaction. At the same time they are extremely rich in organic matter and nitrogen. The application of limestone to these soils will create conditions which make for the activity of those bacteria whose peculiar function it is to fix nitrogen in available forms in the soil independent of any plant associations, and of others whose function it is to effect the complete decomposition of organic matter and the elaboration of the native supply of nitrogen into available forms. On these soils the application of approximately three thousand pounds of limestone per acre has proven to be the equivalent of heavy nitrogenous fertilization.

OTHER CONDITIONS FAVOR RAPID DEVELOPMENT

We have thus far dealt only with topography and soils. There remain to be mentioned briefly several other factors which have a very important bearing upon the development of this cut and burned-over section of the state.

In connection with the lime requirement of the bench and other uplands, mention should be made of the immense beds of high-grade limestone which rise from the water's edge at the head of Pend d'Oreille lake. It should be possible from these and other beds within the section itself to obtain finely ground limestone at a very low cost. The price of lime in other forms is too great to permit of its general use for agricultural purposes.

The mean annual precipitation for the greater part of the section is twenty-five inches. The north and west parts of Bonner and a narrow strip on the west side of Kootenai county receive somewhat less. Local topography, however, plays an important part in determining rain and snowfall for any one locality. Soil moisture on many of the higher benches is supplemented in June by seepage resulting from the slow summer melting of snow accumulations on higher adjoining mountain slopes. Rainfall is lightest during July and August.

In elevation the tillable lands range from sixteen hundred to

thirty-five hundred feet. The lowest are the Kootenai river low lands below Bonners Ferry. Speaking in general terms, the climate is mild, for the entire section lies on the west slope of the continental divide and receives the modifying influences of winds from the north Pacific ocean. Local climate like precipitation, however, is modified greatly by elevation and proximity of mountains and mountain ranges.

In extending their lines to the coast, several transcontinental railroads have built through this section. These main lines, their branches built primarily to serve lumber and mining interests, local roads, lake and river steamers provide transportation facilities for this agriculturally undeveloped section which many well settled communities might with reason envy. Local markets, lumber and mining camps, and markets east and west on main thoroughfares are readily accessible now to those who go upon these lands for settlement and production.

All things considered, the many problems connected with the development of the logged-off lands bid fair to be most satisfactorily solved by families possessed of limited financial means but of unlimited patience, industry and thrift. The initial cost is reasonable. Substantial foundation for soil improvement exists. Cleared of fallen stuff but with stumps untouched, a considerable acreage may be very quickly converted into first class pasture land and means thereby provided for a modest start in dairying and stock growing. Around these industries the development of this section must center. If upon more thoroughly cleared land suitable legumes are grown for forage and winter feeding and everything possible in the way of barnyard manure and litter be concentrated, industrious and thrifty families will quickly find in the ownership of these lands perfect satisfaction and independence.

TABLE 1.

Soil constituents in 3,000,000 pounds of fine soil. (Approximately 9 acre inches)

BONNER COUNTY.

Lab. No.	Where taken	Type and color	Nitrogen N lbs.	Calcium Ca lbs.	Magnesium Mg lbs.	Phosphorus P lbs.	Potassium K lbs.	Sulphur S lbs.
	BENCH LANDS							
814a	Bonners Ferry, 6 mi. N.W.	Fine sandy loam, red	1050	18900	13500	2700	52200	1080
814b*	Bonners Ferry, 6 mi. N.W.	Silt loam, red	900	140400	28500	2400	59700	990
813	Bonners Ferry, 5 mi. N.	Fine sandy loam, red	750	18600	15600	2100	51900	840
881	Bonners Ferry, ½ mi. N.	Sandy loam, red	1080	27300	23400	4800	54900	1380
812	Bonners Ferry, 6 mi. N.E.	Sandy loam, red	900	17700	13200	2100	56400	420
895	Bonners Ferry, 2 mi. S.	Fine sandy loam, red	540	28800	21000	4500	60300	990
877	Bonners Ferry, 1½ mi. S.	Silt loam, red	1500	24300	27900	6300	68100	1800
879	Bonners Ferry, 3 mi. E.	Silt loam, gray	3600	27000	22800	4800	43500	2100
906	Bonners Ferry, 6 mi. S.E.	Silt loam, gray	1800	22200	29700	3900	83700	1860
806	Careywood, low bench	Silt loam, red	1050	24300	12300	3000	53700	570
807	Careywood, low bench	Silt loam, red	1770	30600	14100	4500	49800	2400
808	Careywood, higher bench	Gravelly clay loam, red	1050	22500	16200	2400	53700	210
647	Clagstone, Hoodoo, flat	Gravelly silt loam, dark	4200	39600	10200	6732	51000	720
648*	Clagstone, Hoodoo, flat	Gravelly silt loam, red	1200	26700	10050	1980	83100	600
653	Clagstone, Hoodoo, flat	Gravelly silt loam, dark	4200	32400	9900	4800	46800	600
649	Clagstone, first bench	Gravelly silt loam, red	1800	36600	9000	4350	51900	600
650	Clagstone, second bench (high)	Gravelly silt loam, red	3900	34500	9000	4800	49800	600
652	Clagstone, second bench (low)	Gravelly silt loam, red	2700	43500	9360	4350	46800	600
654	Clagstone, second bench (colluvial)	Gravelly silt loam, dark	5700	36000	8700	6300	52200	720
912	Coleman, low bench	Gravelly sandy loam, red	4800	26400	20400	4110	51100	540
874	Edgemere, Hoodoo, flat	Gravelly loam, red	3300	21300	20100	5700	48900	2550
894	Harlem, low bench	Gravelly sandy loam, red	2700	36900	14700	5550	57000	1800
897	Harlem, low bench	Gravelly loam, dark	780	27300	17100	6000	49500	1320
875	Laclede, south of river	Gravelly silt loam, red	2940	33900	26100	6900	48900	2490
876	Laclede, north of river	Silt loam, red	1200	36000	22500	6000	54300	2400
909	Laclede, north of river	Fine sandy loam, red	1890	24900	17700	5010	55500	510
910*	Laclede, north of river	Fine sandy loam, red	300	26700	17700	3540	59100	600
842	Matchwood	Silt loam, red	2700	21900	12000	5700	41100	450
809	Moyie Springs, ½ mi. S.	Fine sand, red	780	24450	14190	2640	37800	240

* Subsoil.

TABLE 1. —(Continued)

Soil constituents in 3,000,000 pounds of fine soil. (Approximately 9 acre inches)

BONNER COUNTY.

Lab. No.	Where taken	Type and color	Nitrogen N lbs.	Calcium Ca lbs.	Magnesium Mg lbs.	Phosphorus P lbs.	Potassium K lbs.	Sulphur S lbs.
810	Moyie Springs, 2 m. N.W.	Sandy loam, red	1020	21300	12600	2700	57300	180
811	Moyie Springs, Mt. Carmel	Gravelly sandy loam, red	1500	35100	14700	5100	51600	600
902	Moyie Springs, Round Prairie Creek	Gravelly sandy loam, red	3000	29700	15900	9300	43800	1230
360a	Naples, Kootenai Orchard	Silt loam, red	1320	21600	14400	5280	55800	....
360f	Naples, Kootenai Orchard	Silt loam, red	1260	13200	20400	4800	55800	....
907	Newport, Silver Birch Farm	Silt loam, red	4800	25200	19800	5820	50700	1110
908	Newport, Silver Birch Farm	Loam, dark	3600	24900	17700	5010	55500	510
898	Pack River, low flat	Fine sand, red	1440	14400	14100	6000	45000	1590
899	Pack River (Iola)	Loam, red	1470	24300	17100	9900	51000	690
900	Pack River, low flat	Fine sandy loam, red	1500	27000	18000	2400	55800	420
901	Pack River, S. of S. I. bridge	Gravelly silt loam, red	990	18000	19200	4350	58800	1350
841a	Sandpoint, 2 mi. N. low	Silt loam, red	3000	18000	22500	7800	51000	780
841b	Sandpoint, 2 mi. N. low	Silt loam, red	2700	26700	12600	9600	47700	780
843	Sandpoint, ¾ mi. S.W.	Fine sandy loam, red	1200	17100	11400	4800	48900	120
896	Sandpoint, 2 mi. N.	Fine sandy loam, red	1500	25500	13800	9600	46500	1200
	LOW LANDS							
Nos.	665a-889, Kootenai river up and down from Bonners Ferry							
665a	River bank, 5 mi. down	Sandy loam, gray	5400	180000	52500	3300	29630	....
665b*	River bank, 5 mi. down	Sandy loam, gray	6900	180000	33300	3900	78300	....
878	Low, south side, 4 mi. up	Silt loam, gray	5400	179700	58500	5400	60000	3600
880	Low, north side, 2 mi. up	Silt loam, gray	4800	184500	53400	4500	62700	2400
882	Low, north side, 2½ mi. down	Silt loam, gray	5250	181500	50100	4500	63600	3300
883	River bank, N. side 2½ mi. down	Sandy loam, gray	5310	78000	38400	5400	50100	2400
884	Very low, north side, 4 mi. down	Silt loam, gray	12900	55500	32700	4800	73200	6900
885	Higher, north side, 4 mi. down	Silt loam, gray	4050	101700	37200	4200	64500	2880
886	Very low, north side, 7 mi. down	Silt loam, gray	18600	64800	19800	4800	61200	9600
887	Higher, north side, 7 mi. down	Silt loam, gray	6300	137100	14700	4650	65400	2700
888	River bank, north side, 9 mi. down	Sandy loam, gray	5100	177300	36300	5550	58200	2400
889	Low, north side 9 mi. down	Silt loam, gray	6600	134400	49800	6600	66300	1800
805a	Old lake bottom, Careywood	Loam, dark	15000	50700	9900	3300	43200	960
805b*	Old lake bottom, Careywood	Silt loam, gray	2400	50700	9300	3690	54600	660
844	River bottom, west side Clark's Fork	Silt loam, gray	1650	13800	22200	3300	68700	420
903	River bottom, north Moyie Spring	Loam, gray	2460	26100	13500	4980	45300	1350

* Subsoil.

TABLE 1. —(Continued)

Soil constituents in 3,000,000 pounds of fine soil. (Approximately 9 acre inches)

KOOTENAI COUNTY

Lab. No.	Where taken	Type and color	Nitrogen N lbs.	Calcium Ca lbs.	Magnesium Mg lbs.	Phosphorus P lbs.	Potassium K lbs.	Sulphur S lbs.
	UPLANDS, BENCHES AND FLATS							
929	Athol, flat	Loam, red	4500	25200	18300	5400	43800	900
893	Coeur d'Alene, orchard G. M. Stowe	Silt loam, dark	3600	21600	10800	5100	57300	1710
913	Coeur d'Alene, LaFrenz farm	Gravelly silt loam, dark	3900	15900	16500	3000	75300	1350
914	Coeur d'Alene, LaFrenz farm	Silty clay loam, gray	9300	27900	18300	3600	54300	1140
931	Coeur d'Alene, S. Spokane river	Sandy loam, red	3900	33000	13200	6000	71700	900
932	Coeur d'Alene, low bench in city	Sandy loam, red	1500	19500	17400	3000	44100	690
927	Chilco, flat	Gravelly silt loam, red	5100	31200	25800	6000	39600	900
928	Corbin Jct., Eight-mile prairie	Gravelly silt loam, black	16800	30000	35400	7800	44100	2100
796a**	East Greenacres, Spokane valley	Gravelly silt loam, black	10200	48600	41100	5100	42000	750
796b	East Greenacres, Spokane valley	Gravelly silt loam, black	8700	43800	46200	6000	48900	780
796c*	East Greenacres, Spokane valley	Gravelly silt loam, red	2400	36900	44400	2400	51000	450
796d**	East Greenacres, Spokane valley	Gravelly silt loam, black	12000	46500	14700	5400	43200	900
796e	East Greenacres, Spokane valley	Gravelly silt loam, black	16200	33300	19500	4500	43500	1020
850	Fernan Lake, low bench	Loam, black	5100	33300	23400	6300	48000	....
925	Garwood, flat 1½ mi. W.	Gravelly silt loam, red	4080	31800	18900	5700	42000	1800
926	Garwood, flat, 1 mi. N.	Gravelly silt loam, red	7500	40800	34200	6600	40200	900
917	Harrison, high bench, Coeur d'A. river	Silt loam, dark	4500	15900	15300	3300	64200	840
918	Harrison, low bench, Coeur A. river	Silt loam, dark	6000	12600	19800	3600	61800	1470
658a	Hayden Lake, low bench		2370	29500	13800	7200	78300	....
658b	Hayden Lake, hillside		2280	30000	12600	2700	87300	....
933	Plummer, high	Silt loam, red	1950	16200	14400	2700	62400	600
934	Plummer, Plummer creek	Silt loam, dark	2100	31500	21600	3300	56100	300
890	Rathdrum, Rathdrum prairie	Gravelly silt loam, dark	12600	26700	16800	6900	45600	3000
891	Rathdrum, ½ mi. N. E.	Gravelly silt loam, red	6900	24900	24600	6600	48000	1500
911	Spirit Lake, low bench	Gravelly silt loam, red	4500	28200	19200	6000	46800	690
935	St. Maries, city reservoir	Silt loam, red	1500	24600	21300	3600	60000	600
936	St. Maries, C.M. & S.P hospital	Silt loam, red	1800	31500	21900	6600	55500	900
840a	Twin Lakes, low bench	Silt loam, red	2400	38100	13800	5700	52200	600

* Subsoil.

** Light ashy soil, notably unproductive.

TABLE 1. —(Continued)

Soil constituents in 3,000,000 pounds of fine soil. (Approximately 9 acre inches)

KOOTENAI COUNTY

Lab. No.	Where taken	Type and color	Nitrogen N lbs.	Calcium Ca lbs.	Magnesium Mg lbs.	Phosphorus P lbs.	Potassium K lbs.	Sulphur S lbs.
840b	Twin Lakes, higher bench	Gravelly sandy loam, red	3000	27300	23100	5700	53400	380
	BOTTOM LANDS							
915	Coeur d'Alene river near Springton	Silt loam, gray	3600	12600	11700	3660	49200	1050
916	Coeur d'Alene river near Harrison	Clay loam, dark	5700	27900	12300	5550	29400	1200
657a	St. Joe river, St. Maries, Riverdale	Silt loam, black	15900	18000	.....	5700	50400	....
657b	St. Joe river, St. Maries, Riverdale	Silt loam, black	22500	17250	.....	6900	41400	....
657c	St. Joe river, St. Maries Riverdale	Silt loam, black	30900	12900	.....	6300	40200	....
657d	St. Joe river, St. Maries, Riverdale	Silt loam, black	20700	15540	.....	6000	51300	....
657e	St. Joe river, St. Maries, Riverdale	Silt loam, black	14700	19800	.....	5280	50100	....
657f	St.Joe river, St.Maries,Ferguson ranch	Silt loam, black	20400	15900	.....	5400	51000	....
657g	St.Joe river, St.Maries,Bolton ranch	Silt loam, black	24900	16500	.....	4800	47100	....
657h	St.Joe river, St.Maries, DeMer ranch	Silt loam, black	29100	18000	.....	4800	48000	....
657i	St. Maries river, Wolf ranch	Silt loam, gray	5400	21600	.....	5100	41100	....
657j	St. Maries river, Lindstrom ranch	Silt loam, gray	7500	25200	.....	5400	40200	....
657k	St. Maries river, Boedwald ranch	Silt loam, gray	5700	29400	.....	6000	43500	....

TABLE 1. —(Continued)

Soil constituents in 3,000,000 pounds of fine soil. (Approximately 9 acre inches)

LATAH COUNTY.

Lab. No.	Where taken	Type and color	Nitrogen N lbs.	Calcium Ca lbs.	Magnesium Mg lbs.	Phosphorus P lbs.	Potassium K lbs.	Sulphur S lbs.
919	Avon, meadow land	Silt loam, dark	5700	31800	28500	3900	48300	1110
937	Bovill, white pine belt	Silt loam, red	2700	26700	22500	3000	51300	600
930	Deary, 5 mi. S.E.	Silt loam, red	2100	20400	12300	3600	53100	750
938	Deary, ½ mi. E.	Silt loam, red	1800	30000	19800	4200	54300	480
939	Deary, ½ mi. E., low	Silt loam, dark	4800	37500	21900	3900	48900	600
940	Deary, 2 mi. W.	Silt loam, red	2700	27300	17400	3300	51900	690
920	Harvard, upland north of river	Silt loam, dark	3000	35400	26400	3900	54900	900
904	Moscow, 9 mi. E.	Silt loam, black	3900	39000	18300	5100	50400	1290
905	Moscow, 9 mi. N. E.	Silt loam, black	2700	34500	18900	3900	58200	2100
923	Potlatch, upland north of river	Silt loam, black	3600	33600	17100	3900	51600	900
924	Potlatch, upland south of river	Fine sandy loam, red	2310	49800	33900	4500	54600	540
664a	Princeton, bottom land	Silt loam, dark	4500	32400	16800	4800	48900	....
664b	Princeton, bottom land	Clay loam, dark	9300	28800	18300	3600	64500	....
921	Princeton, bottom land	Silt loam, dark	2700	25500	24300	3000	58800	900
922	Princeton, upland, north of river	Silt loam, dark	3900	39000	21300	3600	55800	450
942	Troy, 2 mi. N.E.	Silt loam, dark	1710	30000	23100	3600	52800	450
943	Troy, 5 mi. N. E.	Silt loam, dark	2100	32400	21000	1680	54300	570
944	Troy, 7 mi. N.E.	Silt loam, red	2400	24600	24900	3300	58800	480

TABLE 2.

Pounds of nitrogen and essential mineral elements required of the surface soil of one acre in the making of normal crops.

Crop		Nitrogen N	Calcium Ca	Magnesium Mg	Phosphorus P	Potassium K	Sulphur S
Kind	Yield						
Potatoes	300 bu.	61.00	3.60	5.40	12.00	86.40	5.00
Oats, grain	60 bu.	38.00	1.50	2.40	6.50	8.65	4.00
Oat straw	2 T	22.40	12.00	5.60	4.80	54.00	6.40
Total		60.40	13.50	8.00	11.30	62.65	10.40
Clover, red	3 T	120.00	88.00	24.00	15.00	90.00	9.25
Clover, red	3 T	120.00	88.00	24.00	15.00	90.00	9.25
One rotation—4 years		361.40	193.10	61.40	53.30	329.05	33.90
Wheat, grain	40 bu.	48.00	9.60	2.90	11.00	12.00	3.25
Wheat straw	2 T	19.20	7.60	2.80	4.00	20.80	5.00
Total		67.20	17.20	5.70	15.00	32.80	8.25
Alfalfa	4T	184.00	145.60	15.20	18.40	98.40	20.00
Alfalfa	4T	184.00	145.60	15.20	18.40	98.40	20.00
Mangels	10 T	75.00	21.00	6.00	15.10	124.50	6.00
Barley, grain	50 bu.	38.40	1.00	2.90	8.20	9.40	3.30
Barley, straw	1½ T	19.20	7.00	2.10	2.40	26.40	4.00
Total		57.60	8.00	5.00	10.60	35.80	7.30
Peas, grain	30 bu.	72.00	2.80	2.15	7.75	18.25	6.00
Peas, straw	1¾ T	36.40	49.70	4.00	3.00	31.50	4.00
Total		108.40	52.50	6.15	10.75	49.75	10.00
One rotation—6 years		676.20	389.90	53.25	88.25	439.65	71.55

TABLE 3.

Influence of lime and nitrogen-carriers on crop growth. See figures 4 and 5.

Pot No.	Treatment	Dry matter produced in grams				
		Soil No. 1*		Soil No. 2**		Soil No.3***
		Oats	Peas	Oats	Peas	Peas
1	None	39	61	18	29	56
2	Lime	71	113	95	34	98
3	Manure	85	177	44	135	120
4	Blood	79	134	35	92	82
5	Lime and manure	67	107	41	101	121
6	Lime and blood	46	76	35	77	127
7	Potassium as KCl	47	84	30	63	99

* Gravelly heavy silt loam from the open prairie north of Post Falls.
** Light (ashy) silt loam from the open prairie north of Post Falls.
*** Gravelly red silt loam from Clagstone demonstration farm.

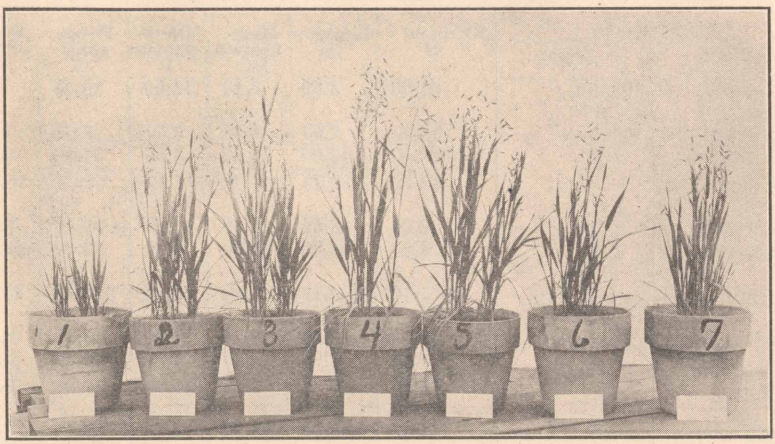

Fig. 4—Pot cultures of oats on a gravelly heavy silt loam from the prairie near Post Falls. For dry weights of crop see Table 3. Note that liming is similar in action to nitrogenous fertilization.

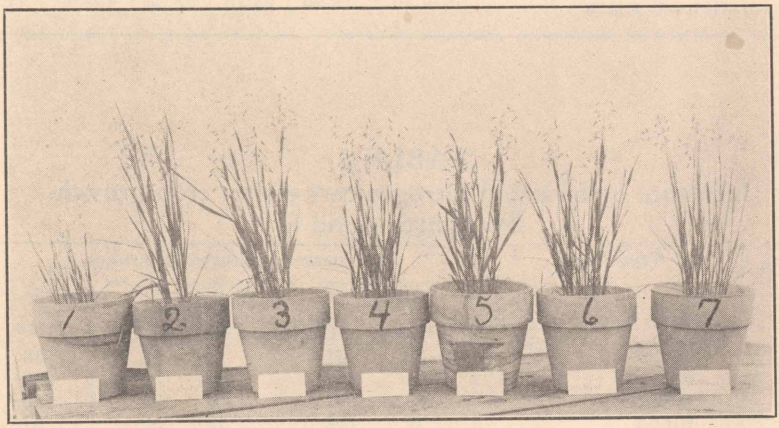

Fig. 5—Pot cultures of oats on a light (ashy) silt loam from the open prairie near Post Falls. For dry weights of crop see Table 3. Note that liming is similar in action to nitrogenous fertilization.